LOWER COLUMBIA RIVER SURVIVAL STUDY, 2010: Passage Behavior and Survival at Bonneville Dam

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Portland District, USACE (Sponsor)

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Objectives

- Deploy double array of hydrophones on each dam face and evaluate detectability in preparation for a 2011 BiOp test
  - Last full project study was a radio telemetry effort by USGS in 2005
- Estimate*:
  - Dam passage survival to primary array 81 km downstream (10 km downstream of confluence of Columbia and Willamette rivers)
  - Survival from forebay entrance array to the primary array
  - Spill passage efficiency
  - Forebay residence time
  - Tailrace egress time

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* Juvenile steelhead and yearling Chinook salmon smolts in spring

Subyearling Chinook salmon smolts in summer

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Objectives (Continued)

- Estimate*:
  - Route-specific & forebay survival rate
  - Passage efficiency metrics
  - Spatial distributions of passage
  - Project passage time (forebay entrance to tailrace exit)
- Evaluate Behavioral Guidance Structure (BGS) in B2 forebay
- Evaluate summer spill treatments effects
  - 24 h 95 kcfs
  - 85 kcfs day & 120 kcfs night

* Juvenile steelhead and yearling Chinook salmon smolts in spring
Subyearling Chinook salmon smolts in summer

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Unique Conditions in 2010

- Powerhouse 1 (B1) sluiceway widened to accommodate more flow from B1 forebay
- Powerhouse 2 (B2) forebay had 700 ft long behavioral guidance structure (BGS) installed
- B2 Turbine 11 out of service all year
- B2 turbine intake extensions installed at every other intake on north half of B2
  - At turbine intakes 15A, 15C, 16B, 17A, 17C, 18B

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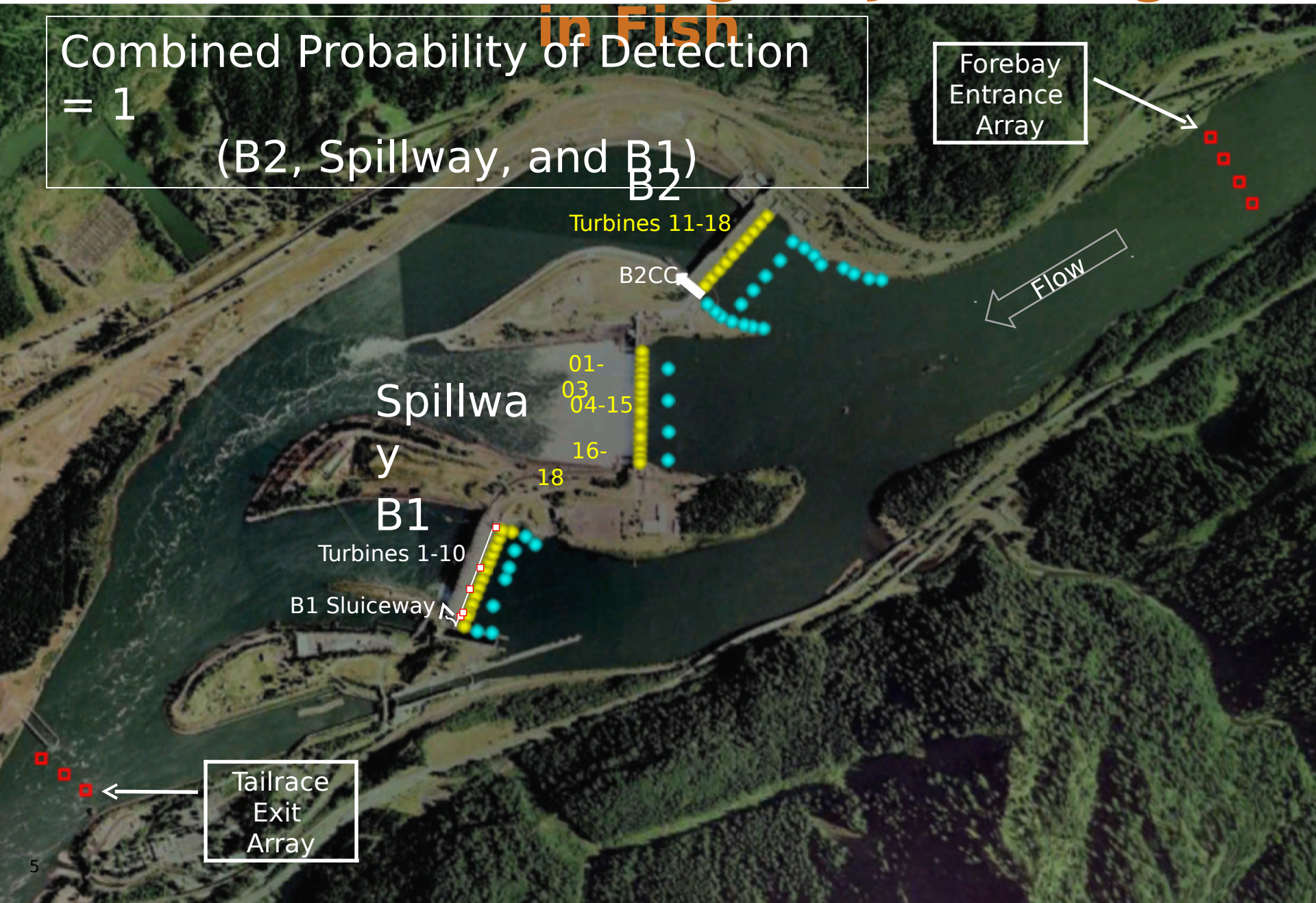
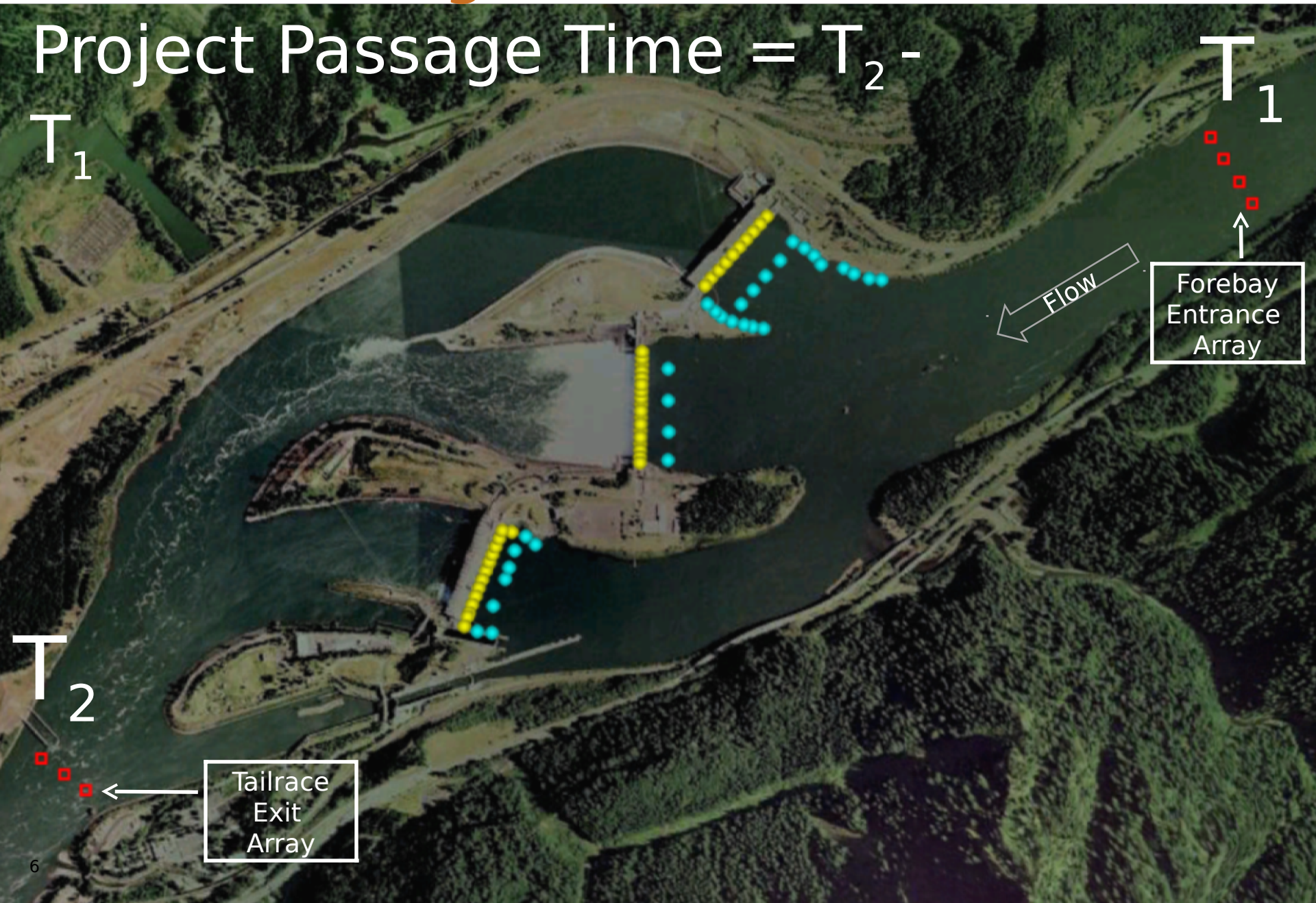
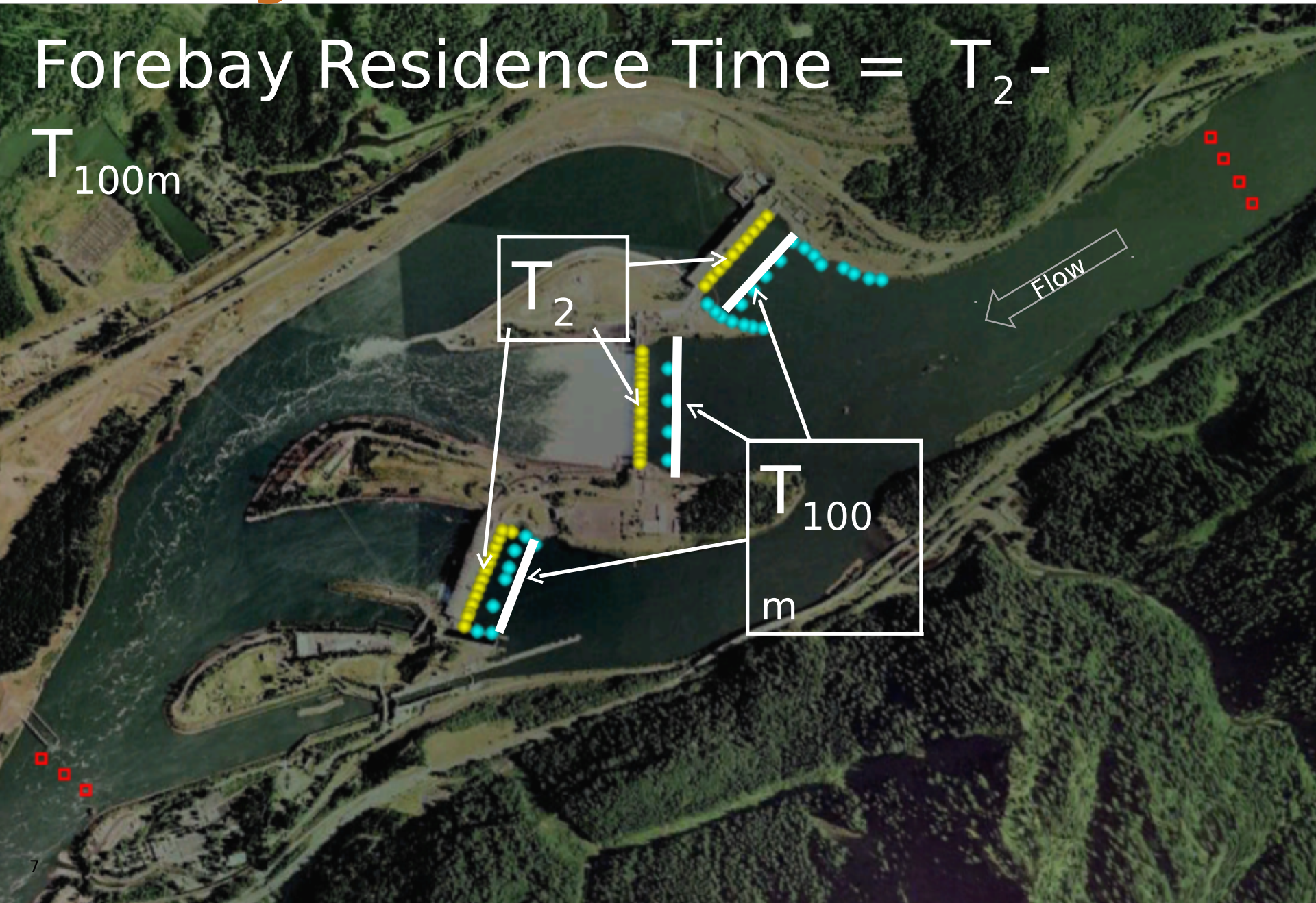
Underwater Listening for JSATS Tags in Fish



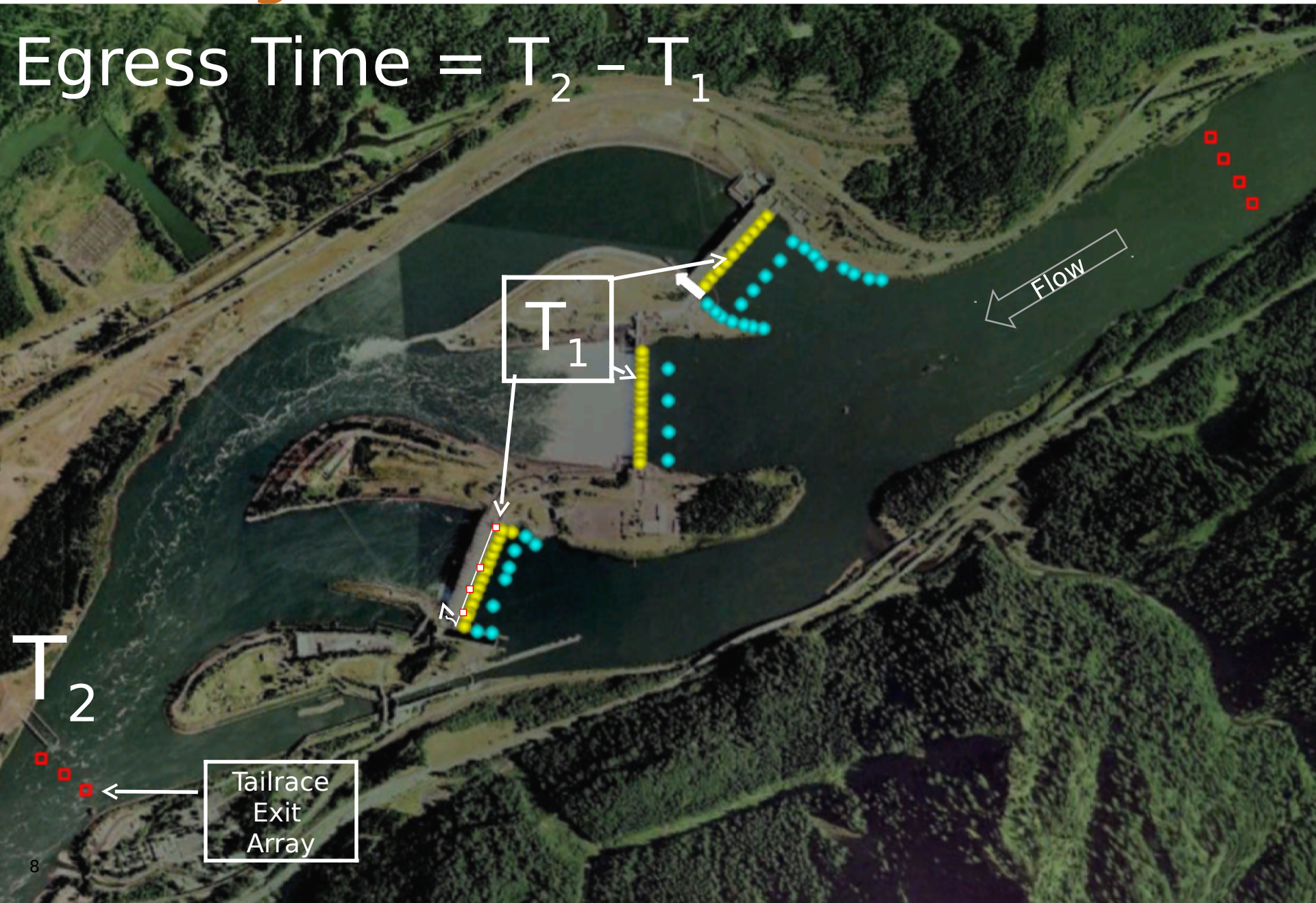
Passage Time Definitions



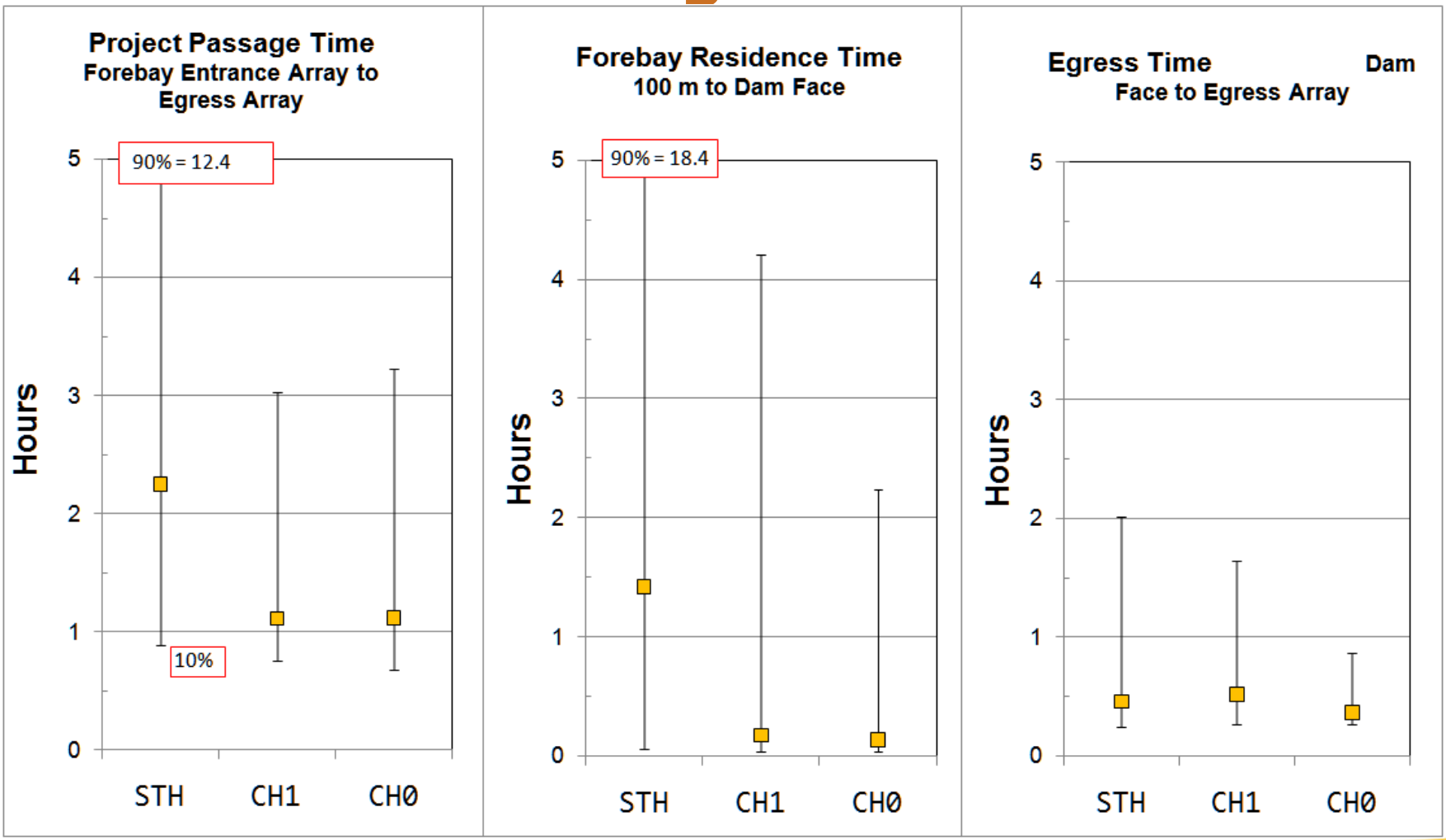
Passage Time Definitions (Continued)



Passage Time Definitions (Continued)



Median Passage Time Metrics



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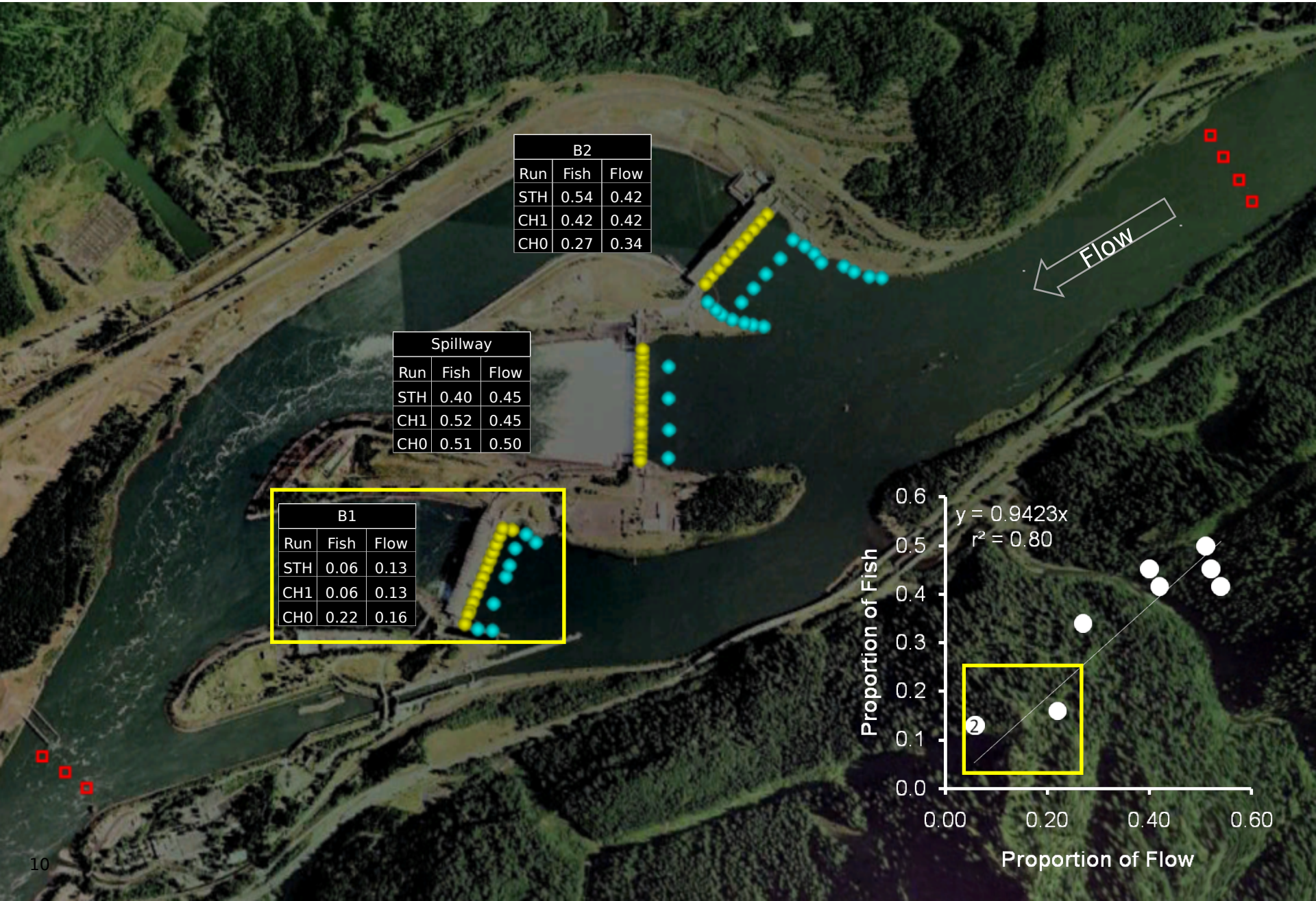
Fish Passage Proportions



Passage Metrics (Percent)

Metric (Percent)	Run of Fish[1]	STH	Historical Range[2]	CH1	Historical Range[2]	CH0	Historical Range[2]
Fish Passage Efficiency (FPE)	| Dam	79.9	78-86	80.50	71-76	70.8	68-90
Spill Passage Efficiency (SPE)	| Dam	39.7	26-55	51.9	33-57	51.9	35-65
Spill + B2CC Passage Efficiency	| Dam	69.8		70.5		60.9	
B1 Sluiceway Passage Efficiency	| B1 (B1 FPE)	40.8	29-65	33.0	29-53	25.6	29-59
B2CC Passage Efficiency	| B2	*55.0	59-75	44.0	29-49	*34.9	37-40
B2 Fish Guidance Efficiency	| JBS+Turbine	46.4	34-59	*51.4	33-46	24.8	22-47
B1 Sluiceway Passage Efficiency	| Dam	2.3		1.9		5.6	
B2CC Passage Efficiency	| Dam	30.0		18.6		9.0	
B2 JBS Passage Efficiency	| Dam	7.8		8.1		4.2	

[1] STH = juvenile steelhead

CH1 = yearling Chinook salmon

CH0 = subyearling Chinook salmon

[2] Non-drought years except for B2 FGE

* Unit 11 out of service all year

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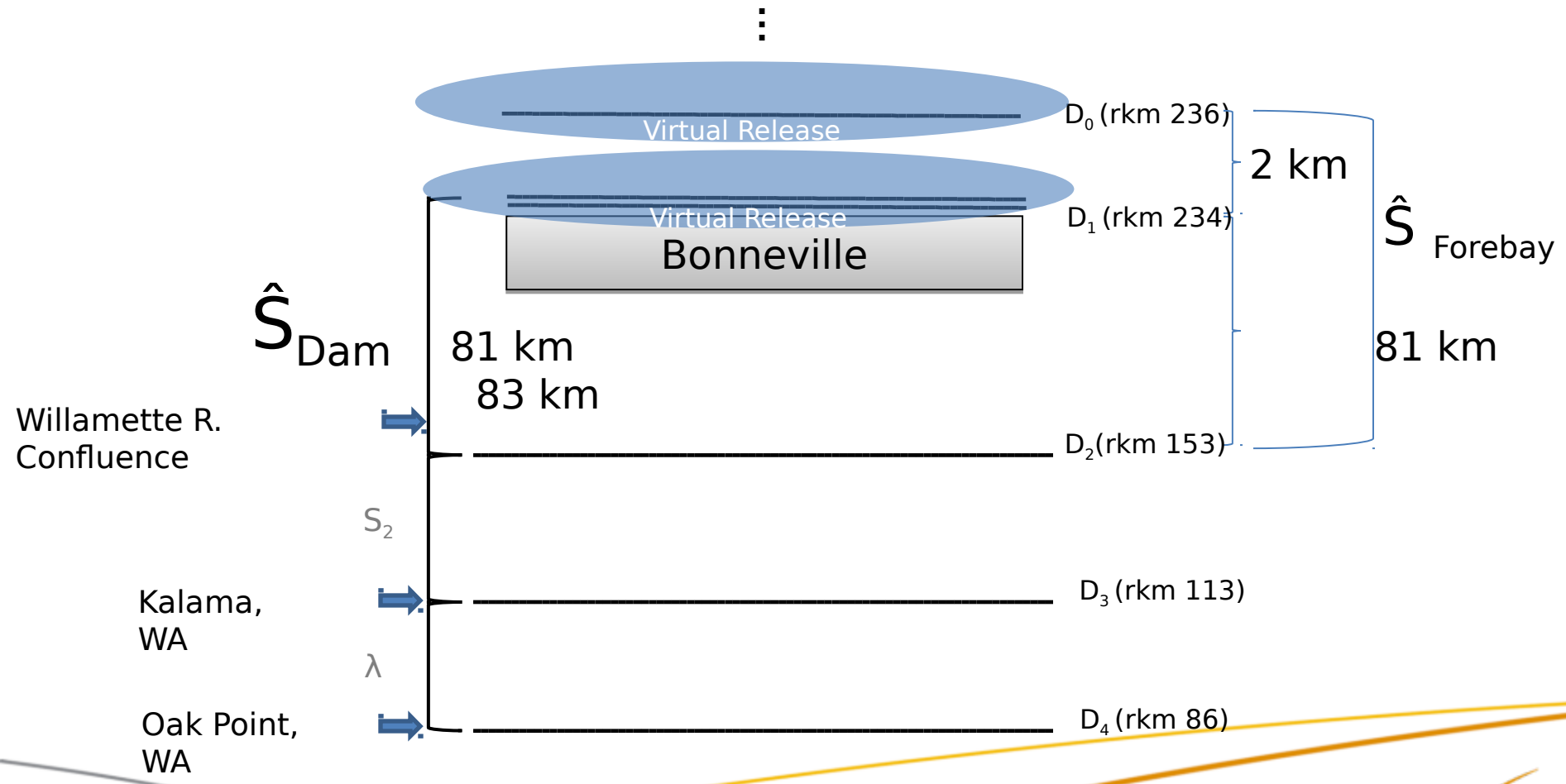
Three Fish Release Locations

R_1 Roosevelt, WA (Rkm 390)
R_2 The Dalles, OR (Rkm 307)
R_3 Hood River, OR (Rkm 275)



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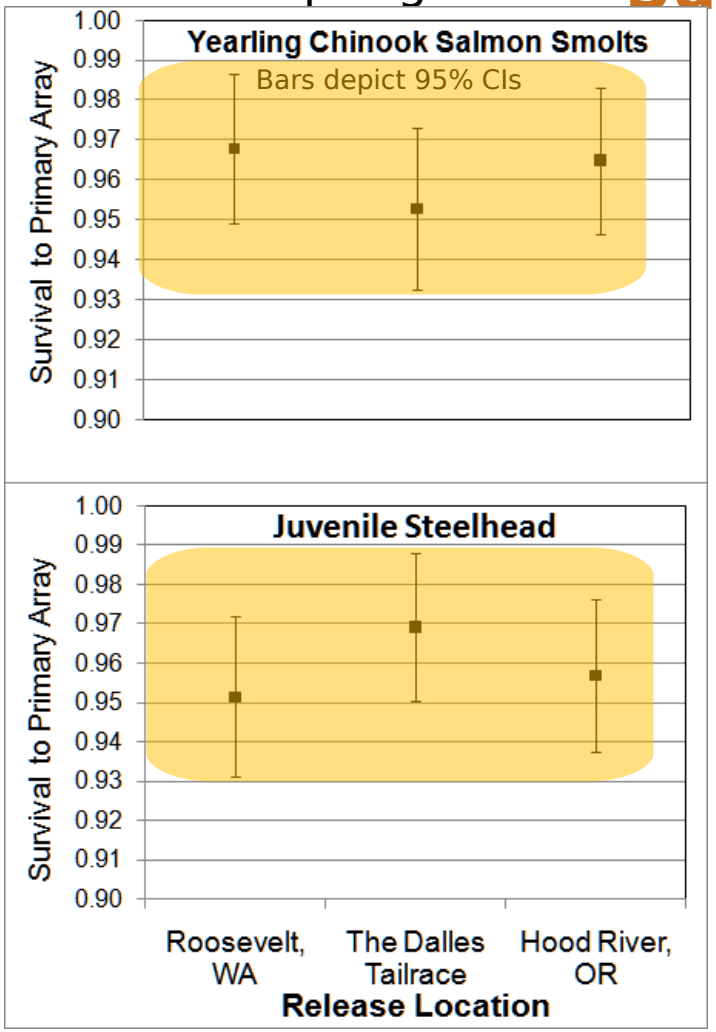
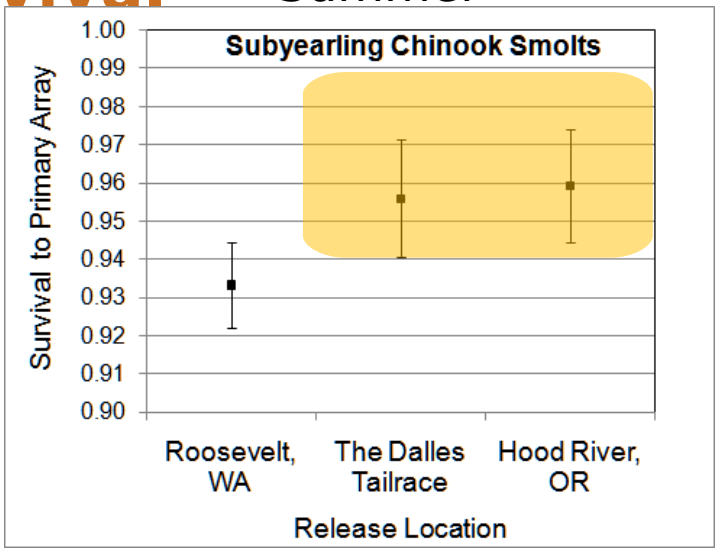
Release-Location Effects on Dam-Passage Survival

Spring



Summer



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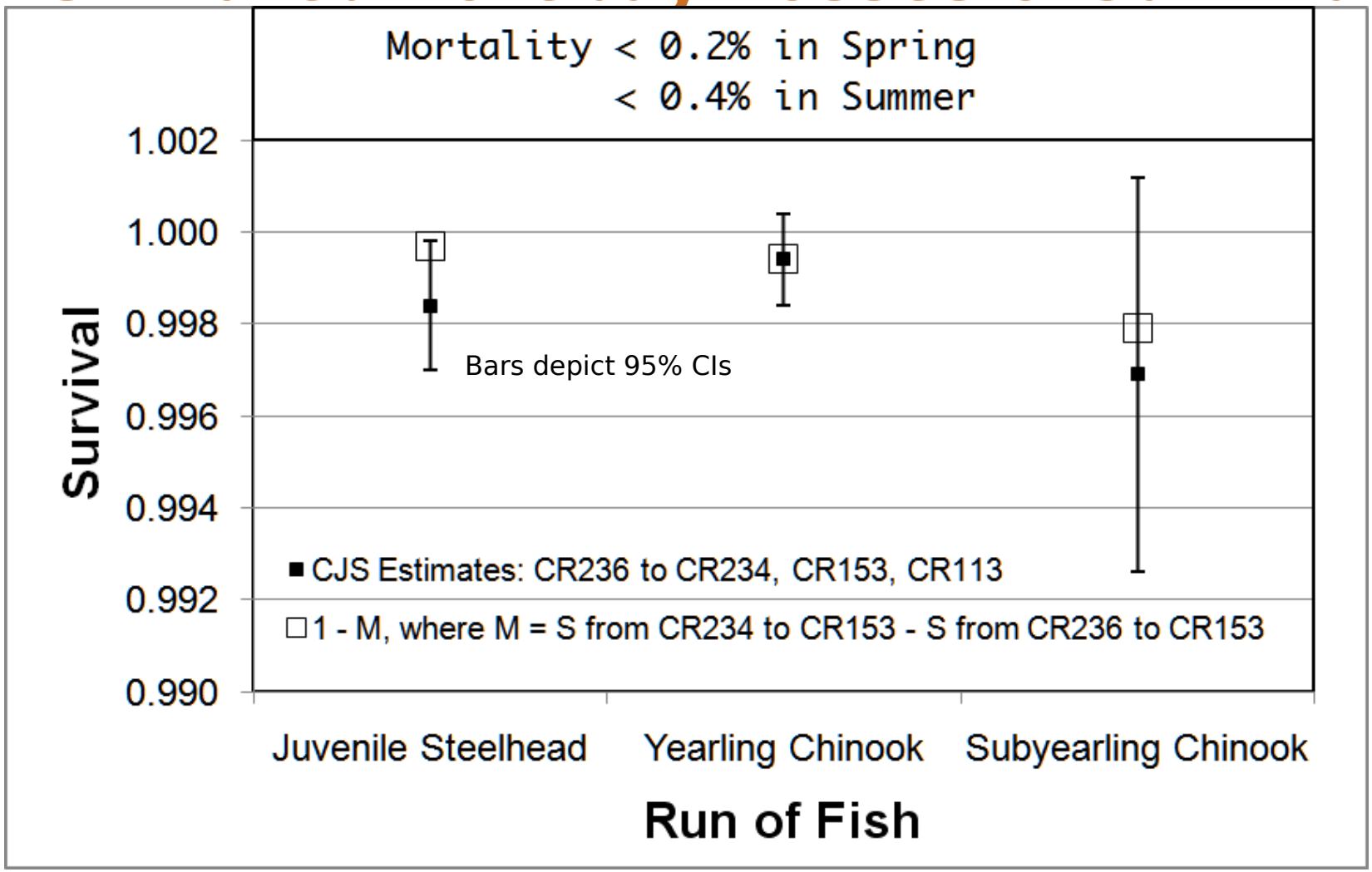
Estimated Forebay Losses & Survival



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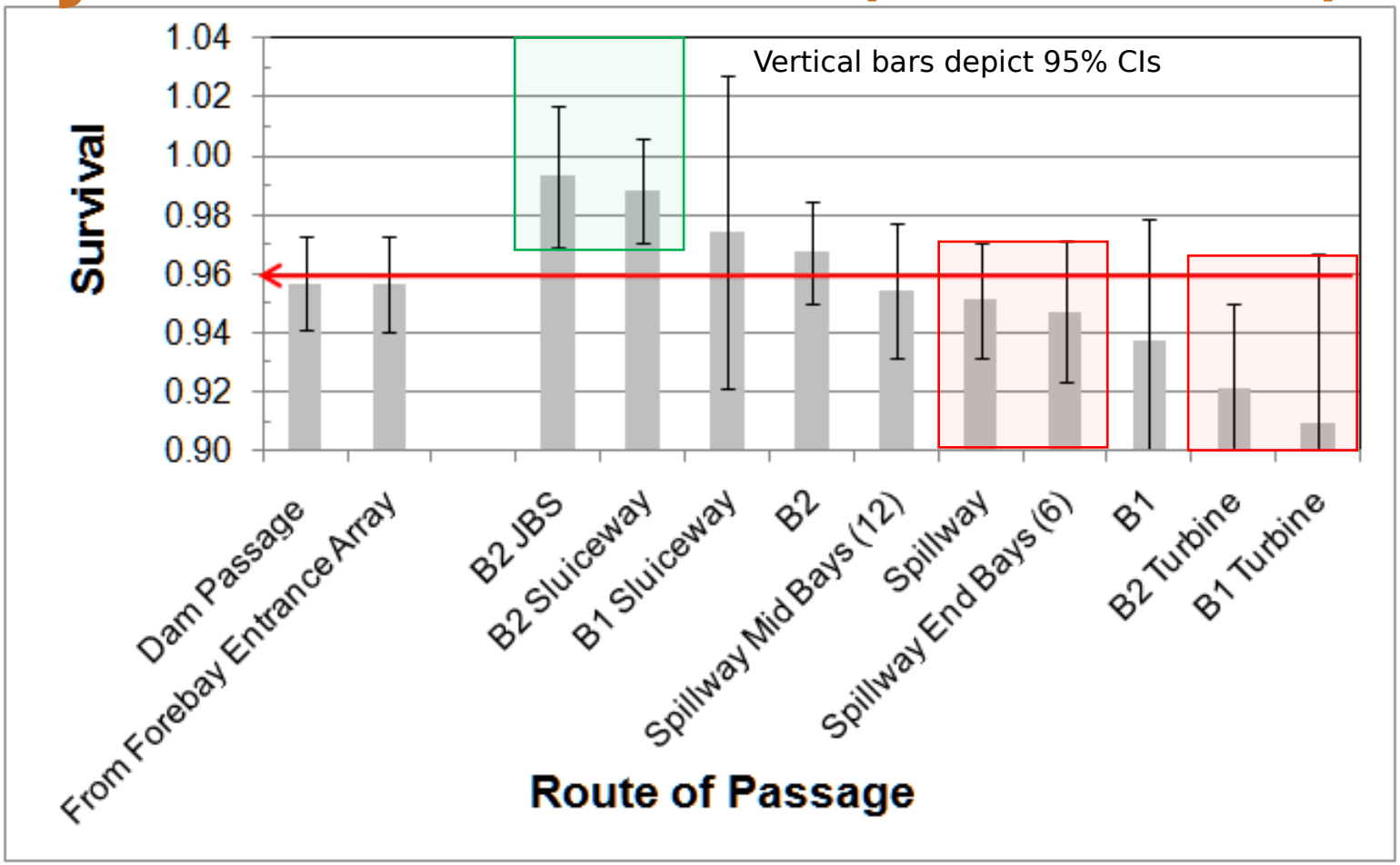
Dam-Passage Survival Estimates For Juvenile Steelhead (Dam + 81 km)



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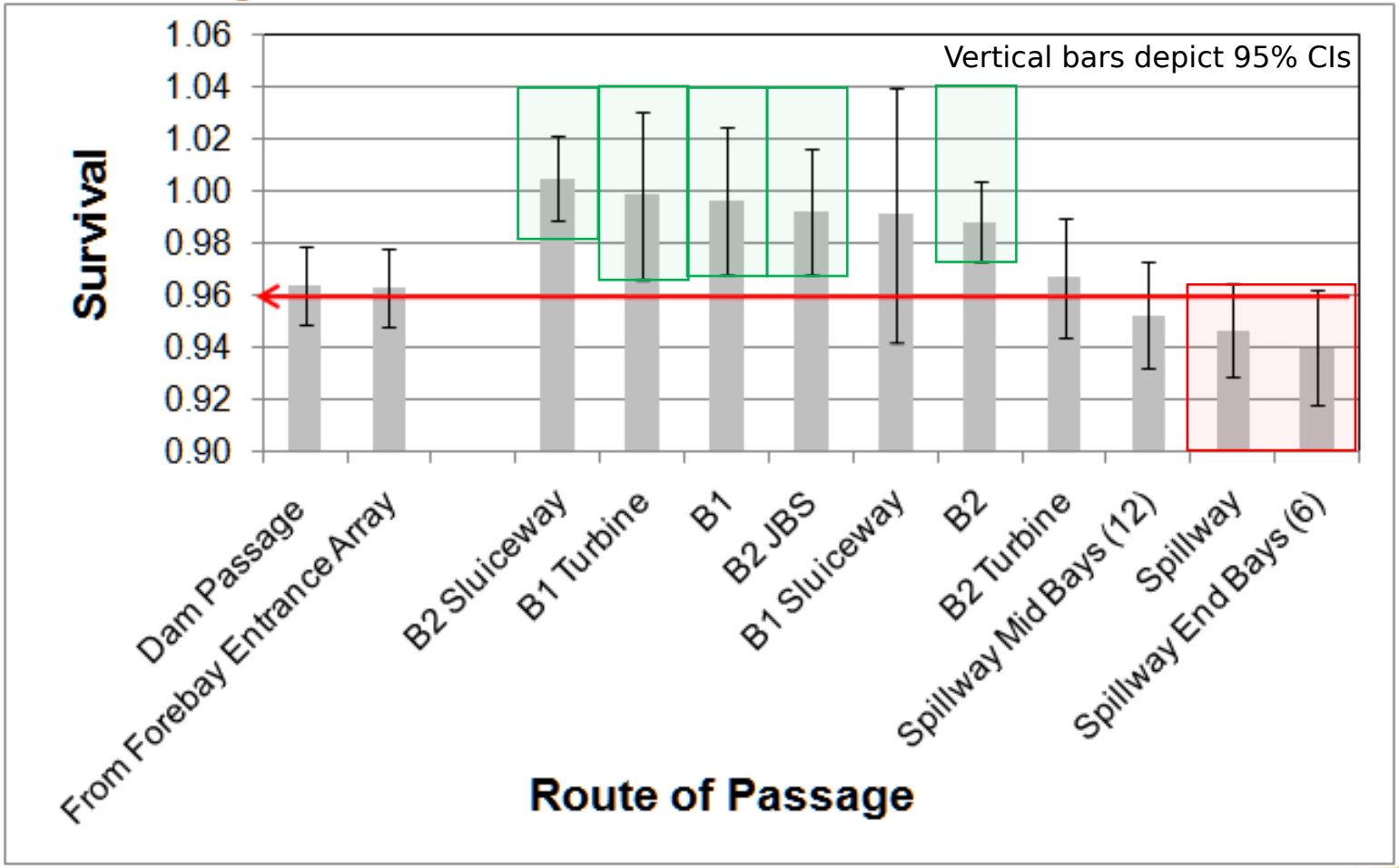
Dam-Passage Survival Estimates for Yearling Chinook Salmon (Dam + 81 km)



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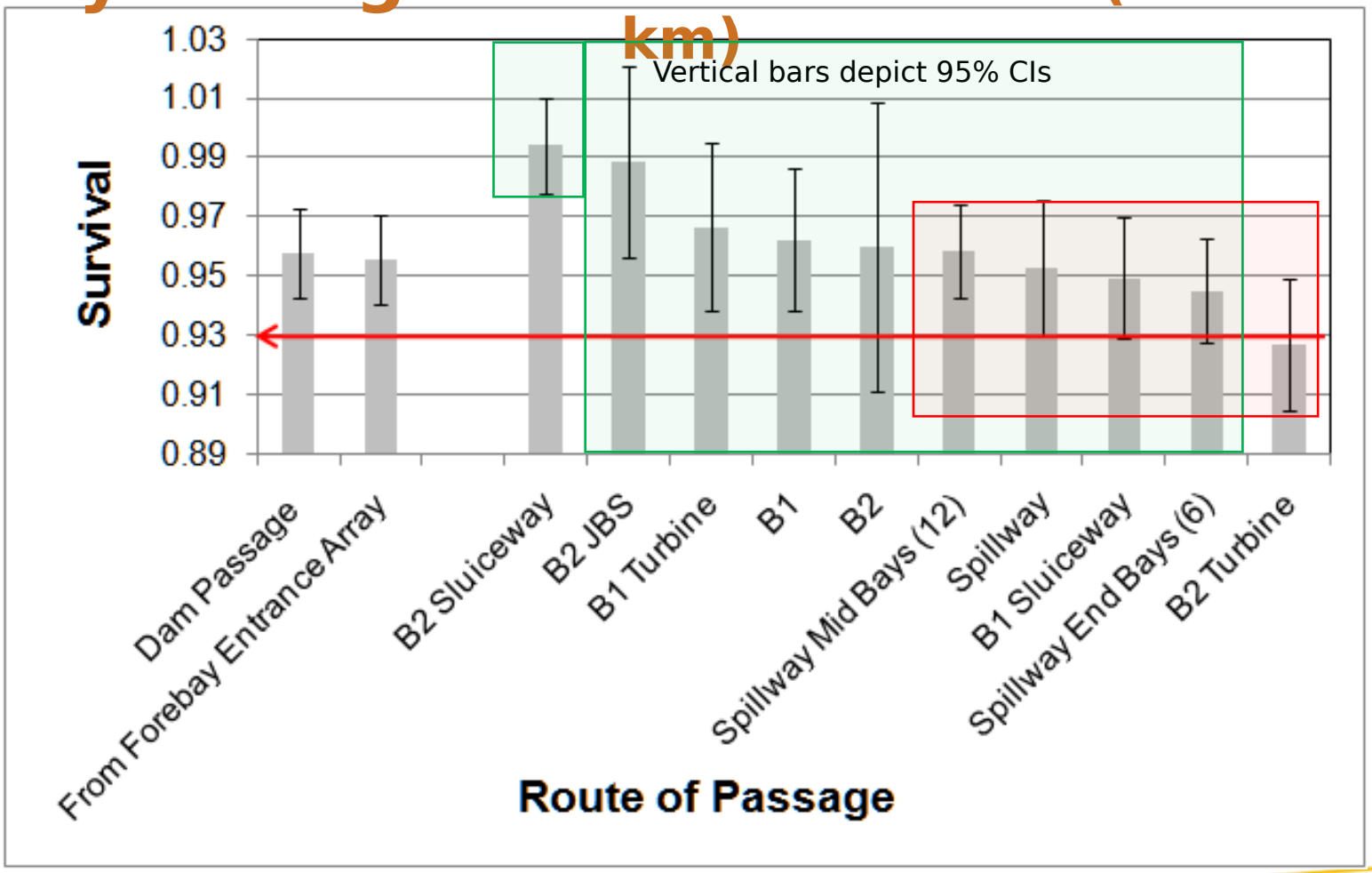
Single-Release Survival Estimates for Subyearling Chinook Salmon (Dam + 81 km)



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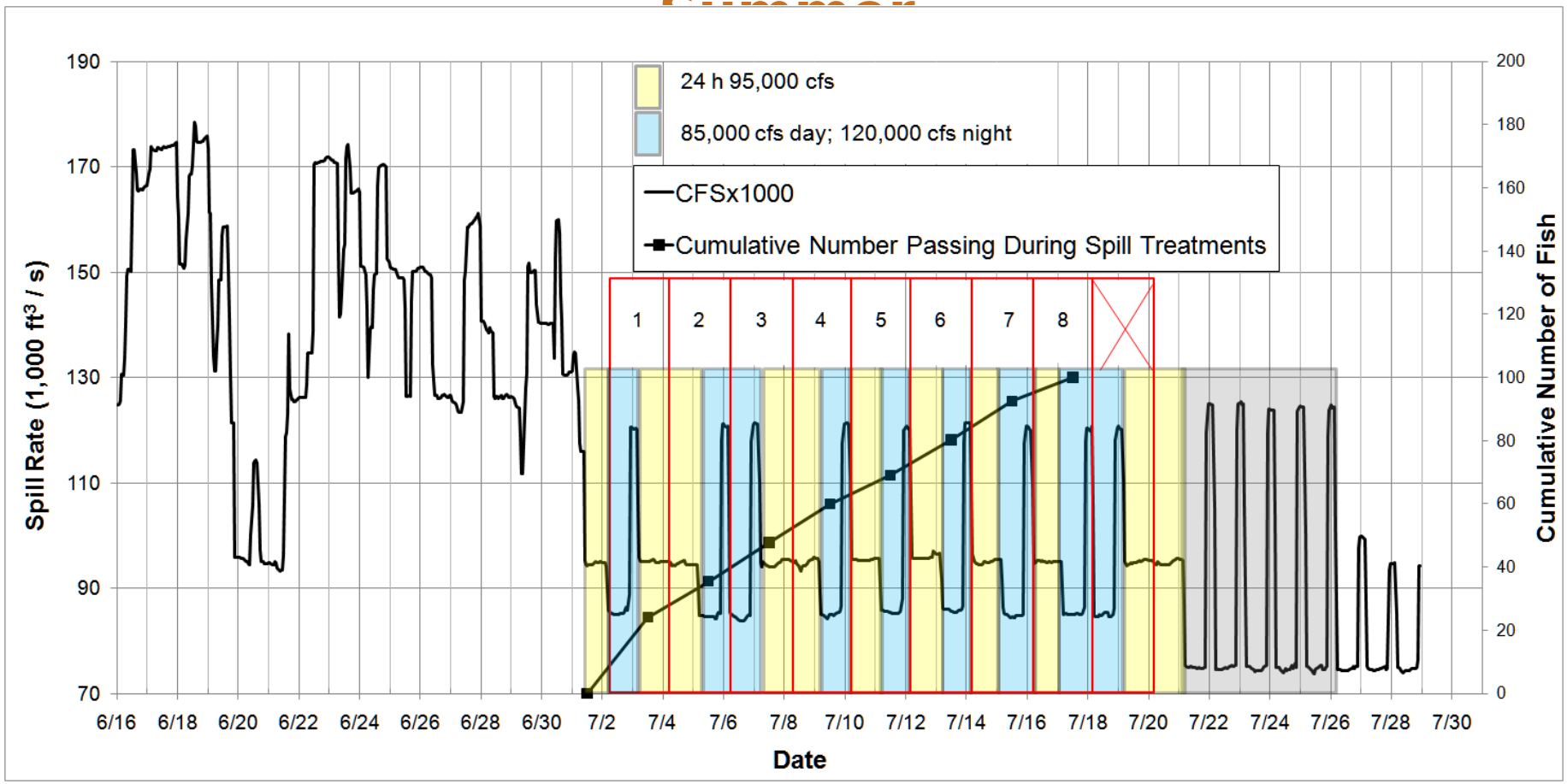
Prescribed & Realized Spill Treatments in Summer



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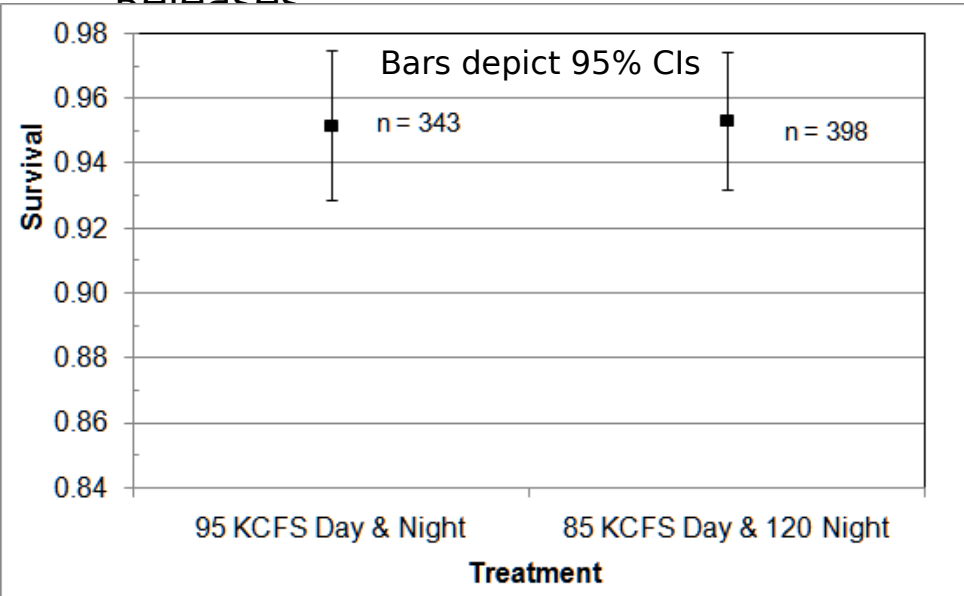
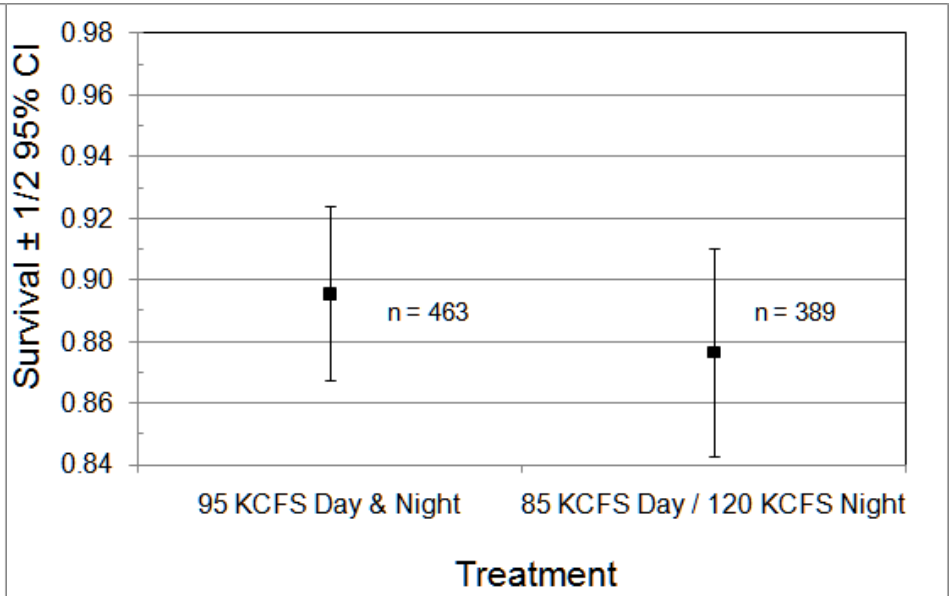
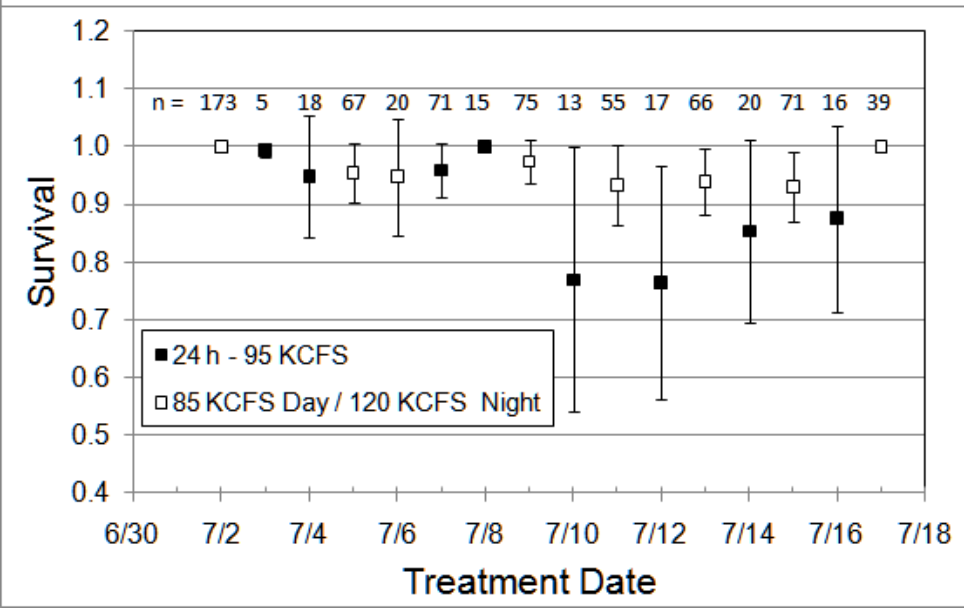
Effect of Summer Spill Treatments

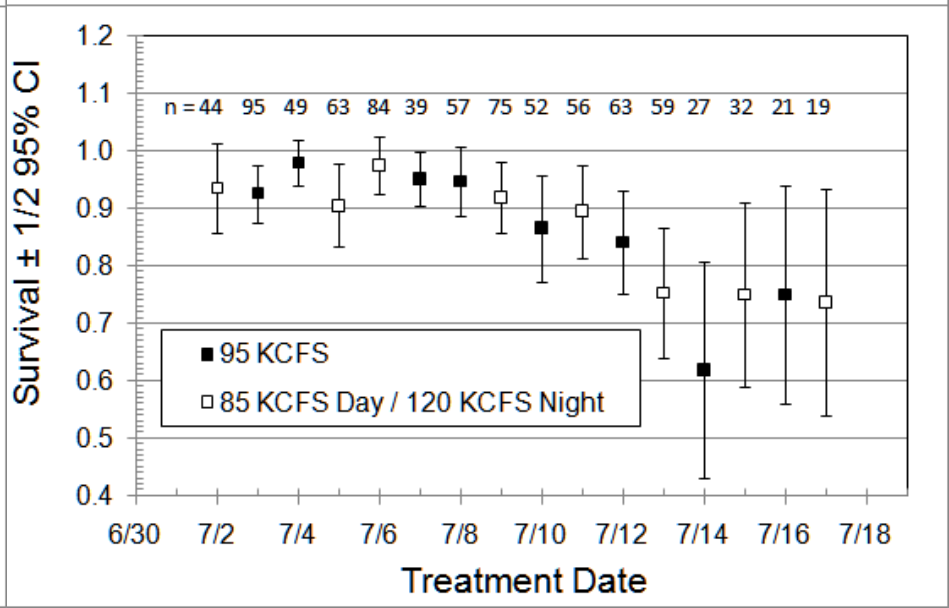
The Dalles Tailrace & Hood River Releases



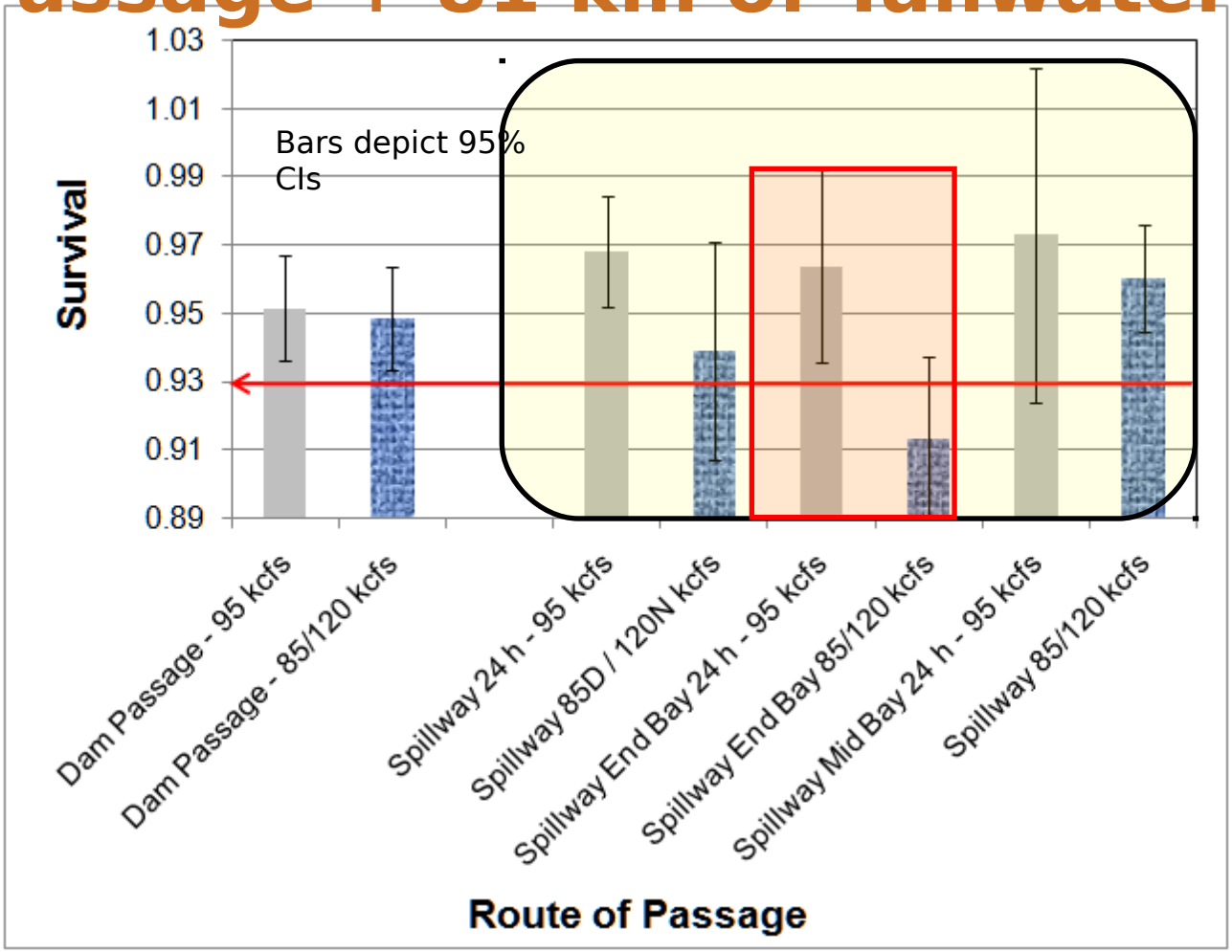
Roosevelt Releases







Effects of Spill Treatments by Route (Passage + 81 km of Tailwater)



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Conclusions

- **Ready for 2011 BiOp test**
  - Hydrophone deployments successful
  - Detection probabilities of double arrays on dam faces = 1
- **Most passage efficiency metrics were within historical range or just 3-5% out of range**
  - Spillway passage efficiency was similar to estimates for non-drought years
  - Having Unit 11 out of service degraded B2CC passage efficiency relative to other years in spite of forebay BGS
- **Single-release estimates of dam-passage survival were high for yearling and subyearling Chinook and were close to the BiOp standard juvenile steelhead**
  - Standard errors met BiOp precision requirements
  - Differences in route specific survivals were informative
- **Passage survival of subyearling Chinook salmon and other passage metrics did not differ among spill treatments**
- **Point estimates of spillway survival were higher under 24 h 95 kcfs spill than under 85D/120N treatment, particularly through end bays**

Acknowledgements

- **PNNL**: T Carlson, C Arimescu, G Batten, B Bellgraph, R. Brown, S Carpenter, J Carter, K Carter, E Choi, Z Deng, K Deters, G Dirkes, Faber, E Fischer, T Fu, G Gaulke, K Hall, K Ham, R Harnish, M Hennen, J Hughes, M Hughes, G Johnson, F Khan, J Kim, K Knox, B Lamarche, K Lavender, J Martinez, G McMichael, B Noland, E Oldenburg, G Ploskey, I Royer, N Tavan, S Titzler, N Trimble, M Weiland, C Woodley, and S Zimmerman

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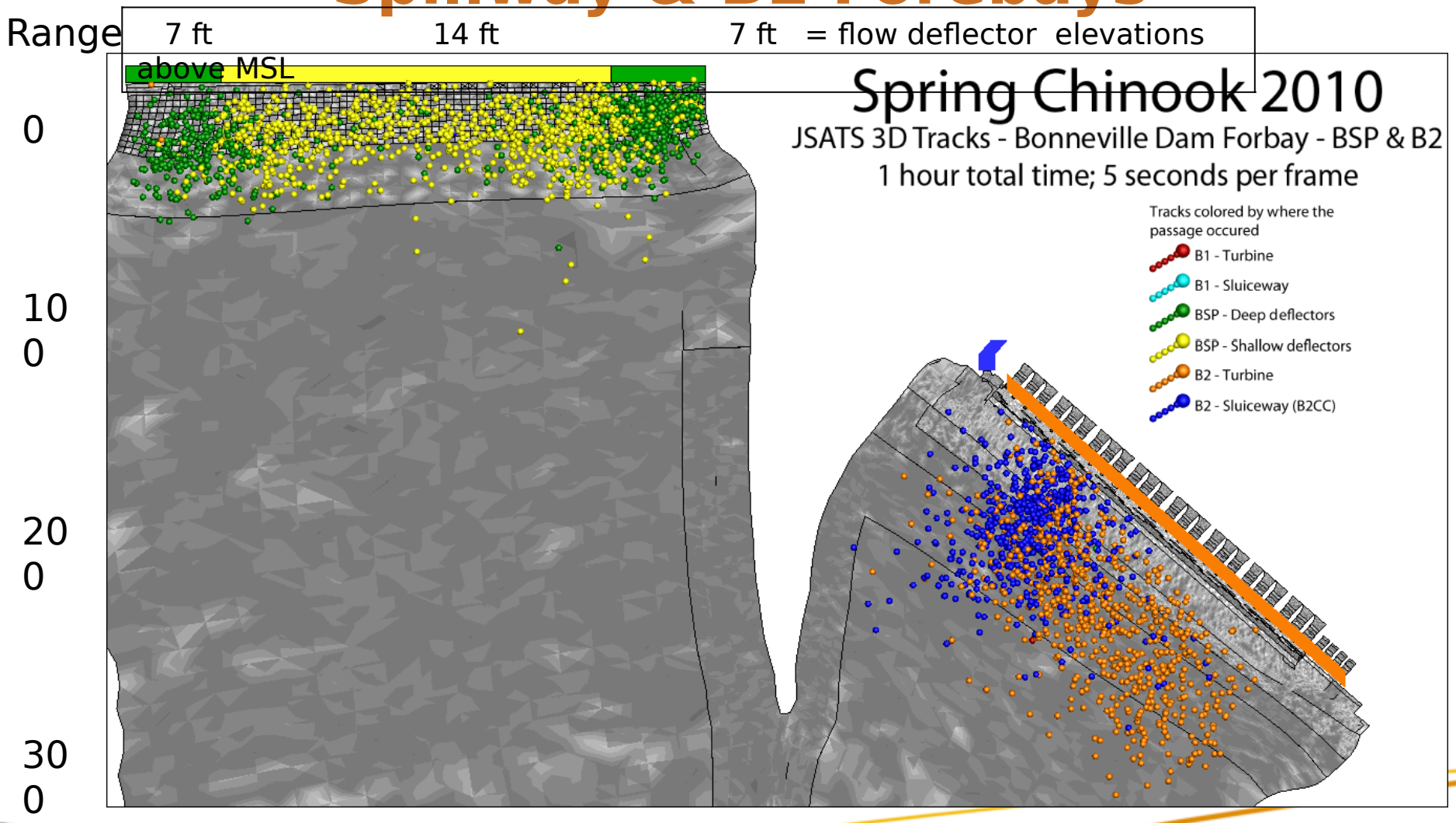
Yearling Chinook Salmon Behavior: Spillway & B2 Forebays



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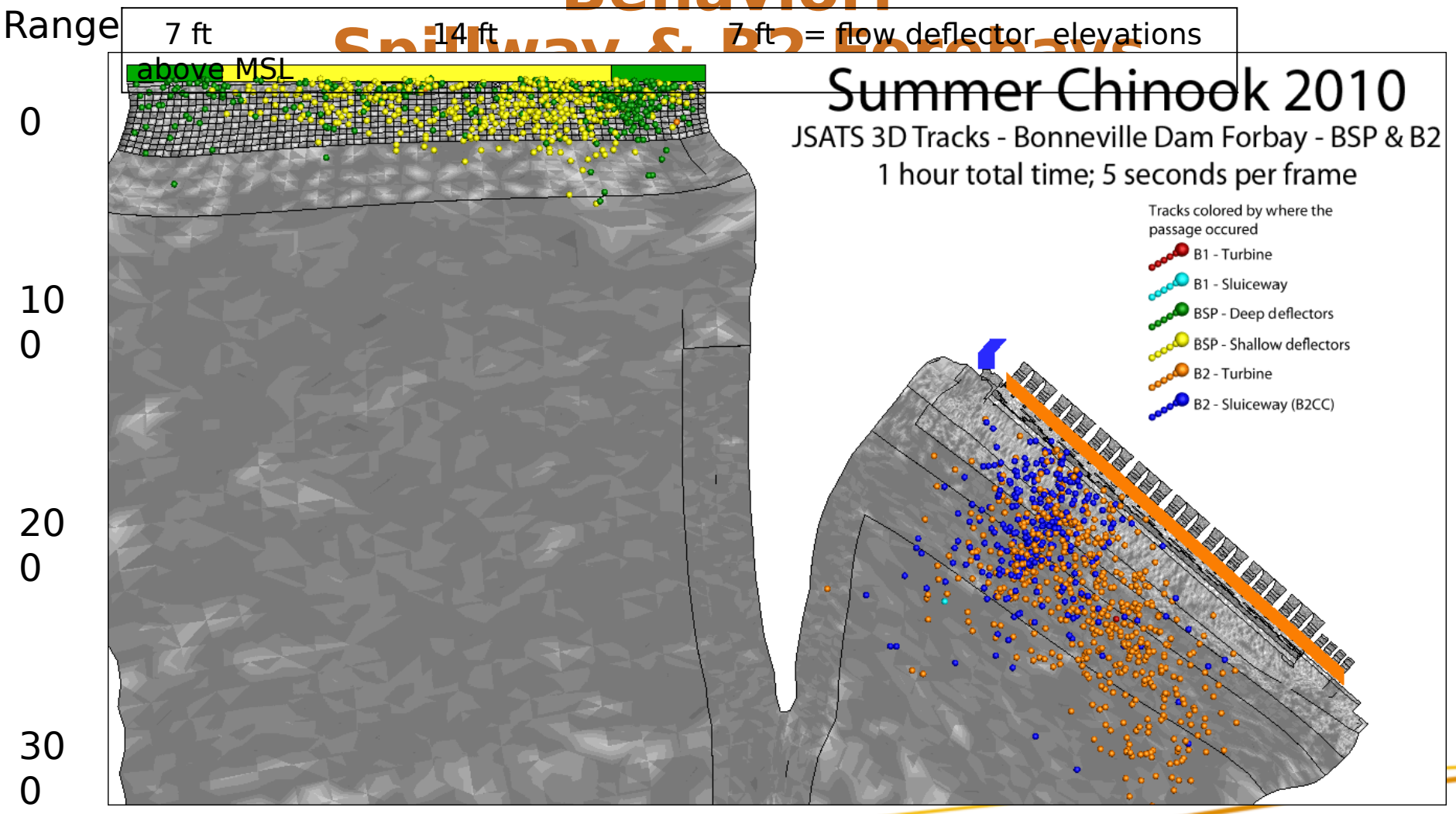
Subyearling Chinook Salmon Behavior: Spillway & B2 Forebays



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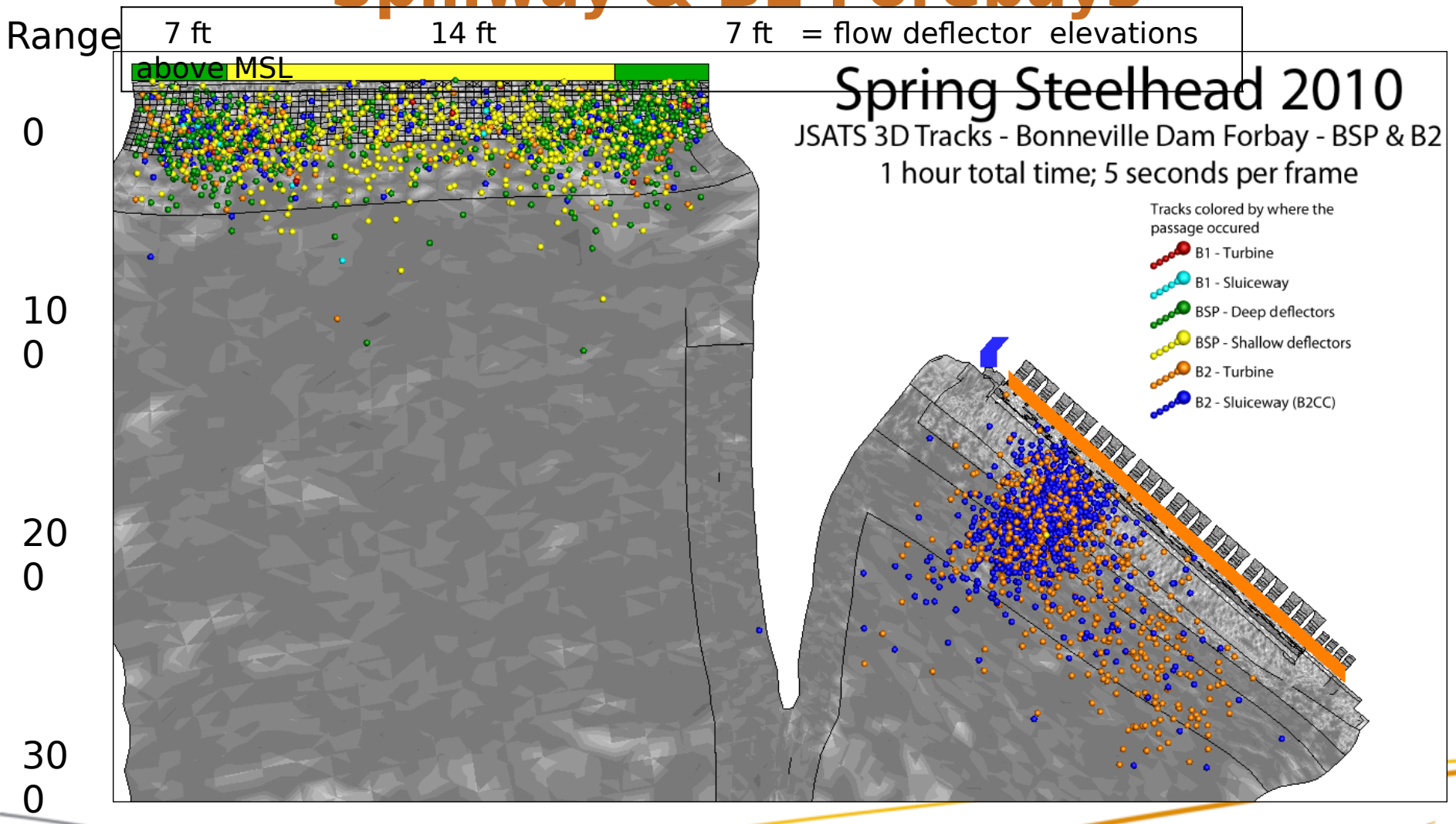
Juvenile Steelhead Behavior: Spillway & B2 Forebays



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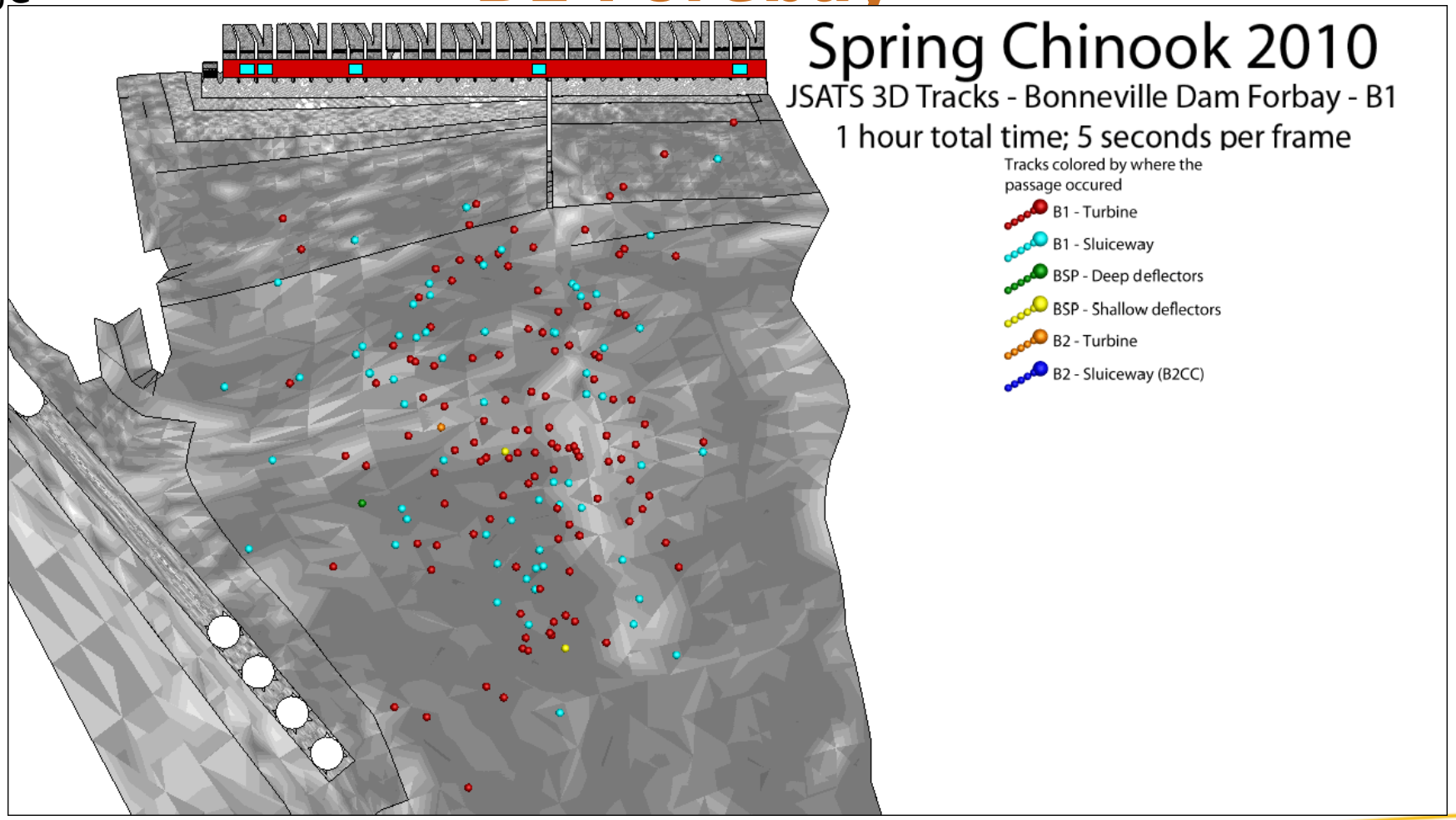
Yearling Chinook Salmon Behavior: B1 Forebay



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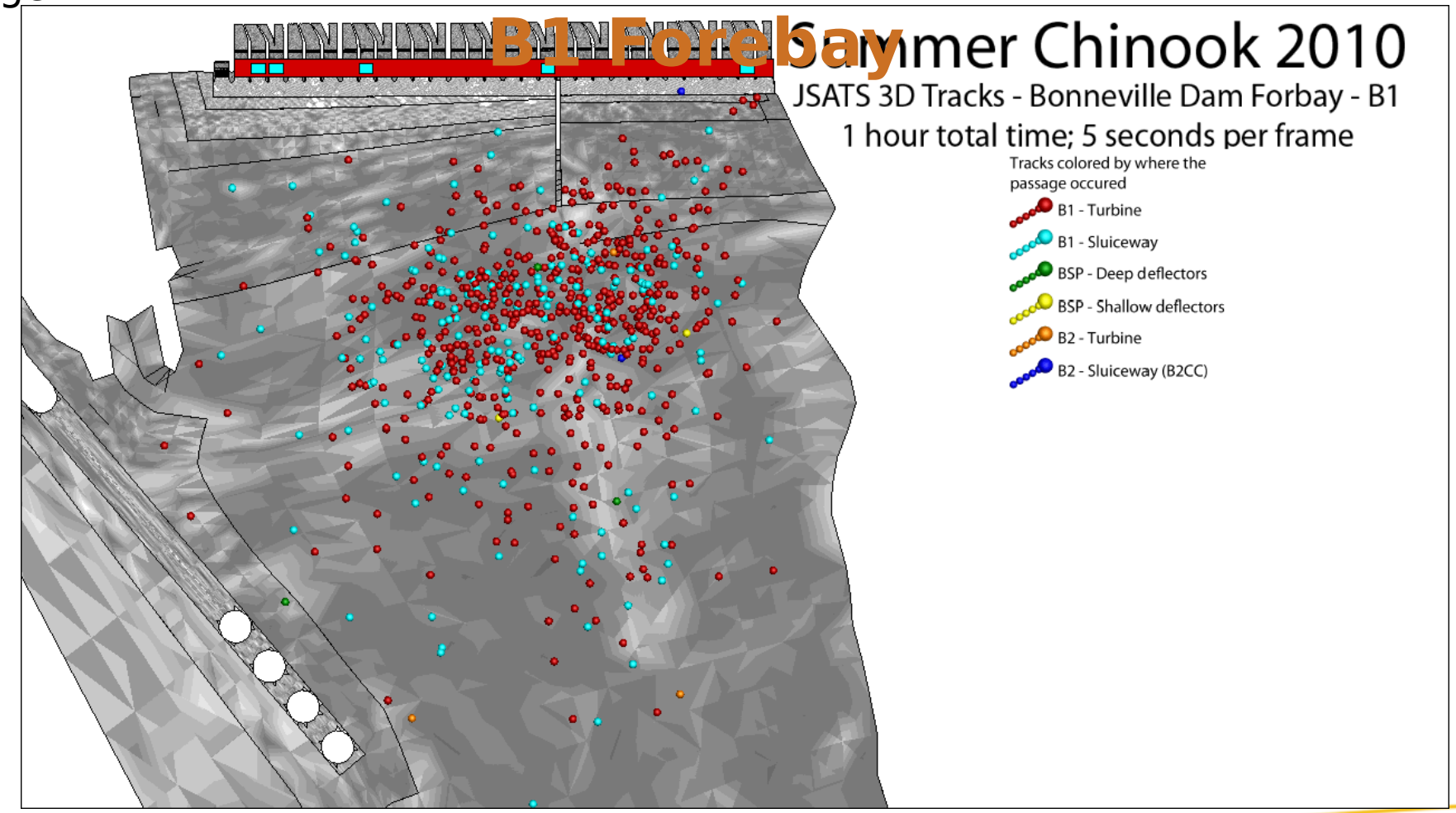
Subyearling Chinook Salmon Behavior: B1 Forebay



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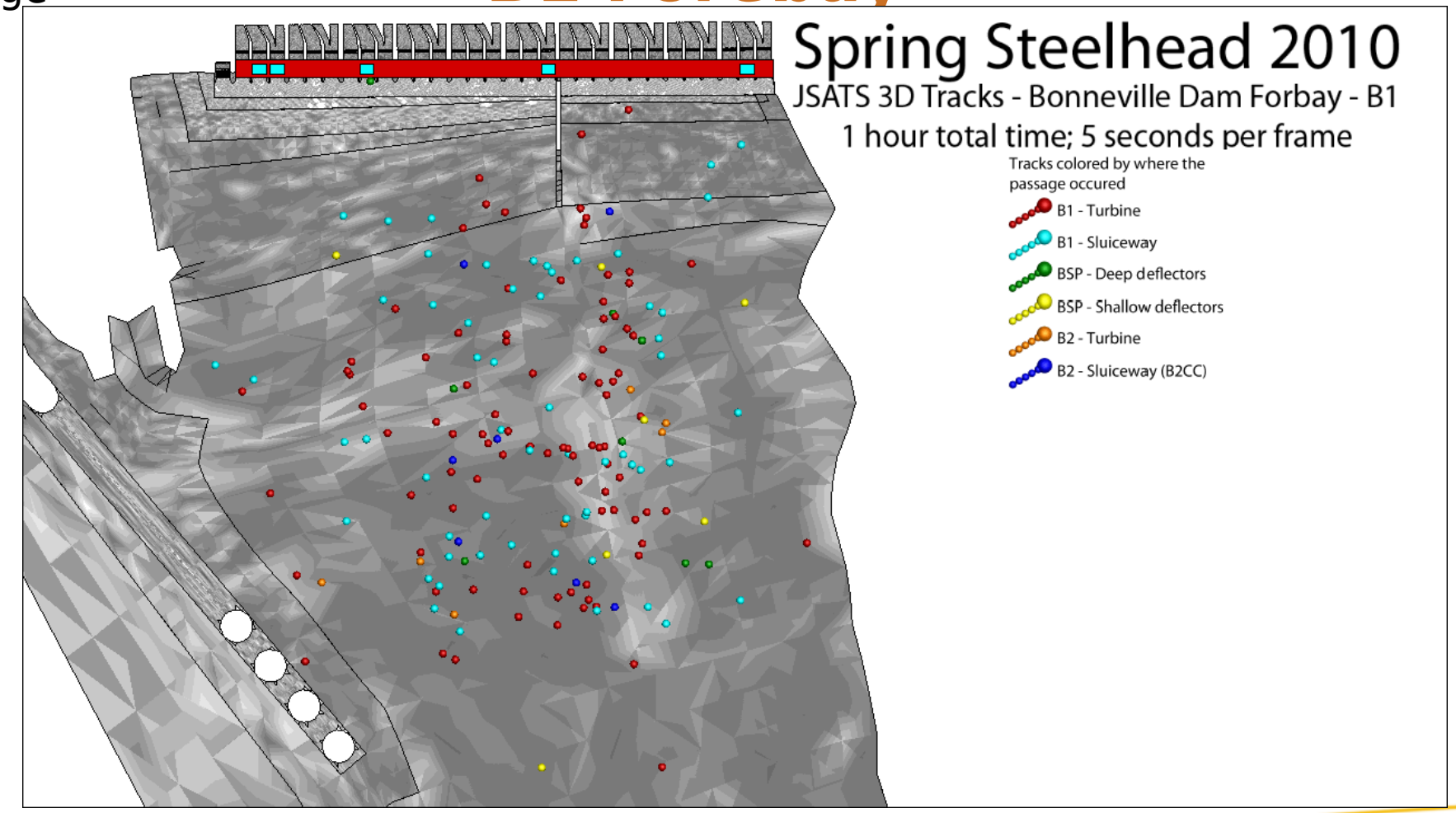
Juvenile Steelhead Behavior: B1 Forebay



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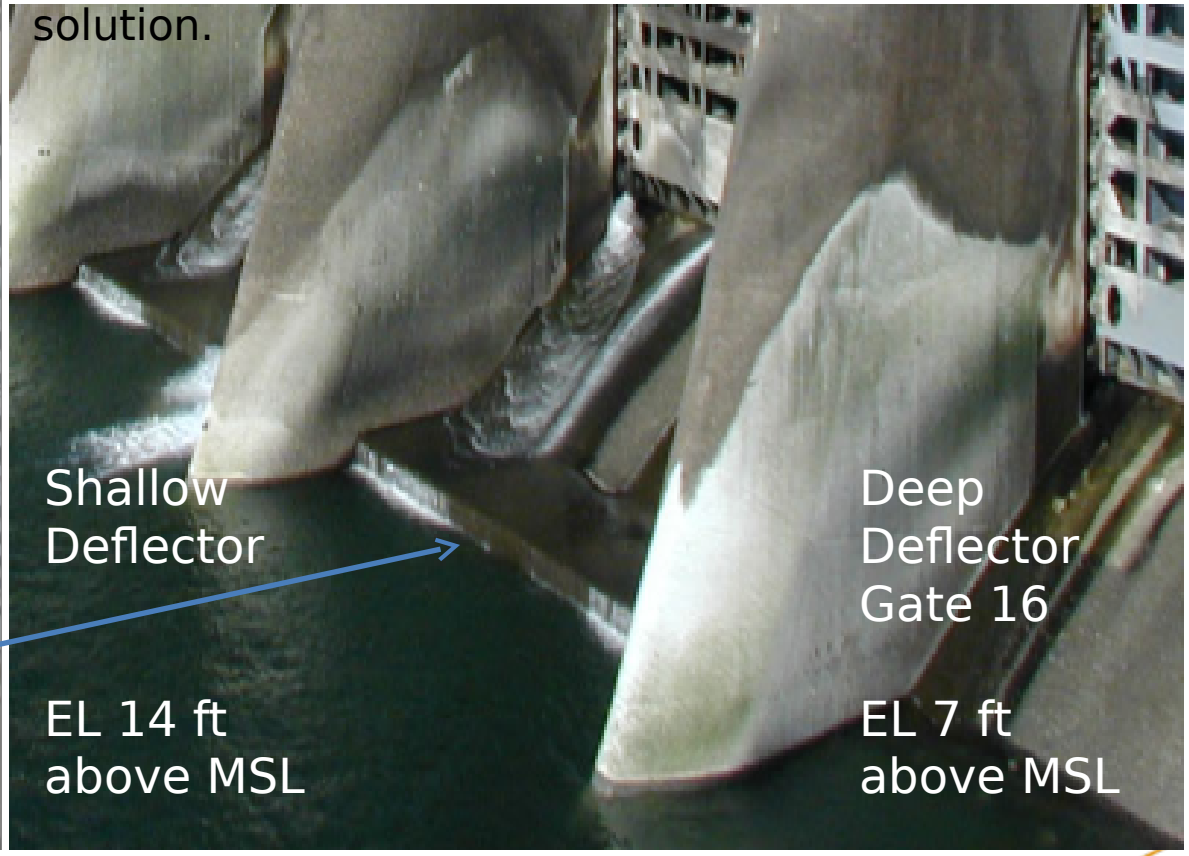
Flow Deflectors Downstream of Spill Gates

Flow deflectors were added after construction of the spillway, and were designed to divert flow over baffle blocks and reduce the amount of air forced into solution.



Spill Gates 12-15; Gate 16

Photos were provided by Dennis Schwartz

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